Niveau(x) d'enseignement: 4 Numéro EDUQ : 8770945
Centre d'intérêt: 840

Rearrangement of the chemistry and physics programs : second cycle of secondary schools / Direction générale des programmes, Direction de la formation générale. -- [Québec] : Ministère de l'éducation, c1986.
64 p. ; 26 cm. -- (Information document / Ministère de l'éducation du Québec, Direction de la formation générale)

Code: 16-3155A ; 8687-322.

ISBN 2-550-13347-1

Vedette(s)-secondaire(s): Québec (Province) Ministère de l'éducation. Direction de la formation générale

Descripteur(s): Programme d'enseignement * Chimie * Physique * Régime pédagogique * Guide pédagogique * Secondaire (Ordre d'enseignement)

Le guide pédagogique vise à aider la mise en application des nouveaux programmes de chimie et de physique offerts au secondaire, en quatrième et cinquième années. L'implantation du nouveau régime pédagogique pour la quatrième et la cinquième année du secondaire a eu lieu en septembre 1986 et 1987. Afin de pouvoir résliser l'enseignement du nouveau programme en 100 heures, au lieu des 150 heures de l'ancien programme, le document donne sur le côté gauche de la page l'ancien pgrogramme en 150 heures (sauf pour le programme de Science 412) et sur le côté droit le contenu modifié du nouveau programme en 100 heures, tel que proposé par le ministère de l'Education. Ces suggestions visent à apporter une certaine uniformité au niveau provincial et à aider les enseignants à adapter ces programmes pour leurs étudiants selon le temps qui est alloué au programme.

Type de document: d
Notice(s) connexe(s): 8770297, 8770944

UQ 8770945

INFORMATION DOCUMENT

REARRANGEMENT OF THE CHEMISTRY AND PHYSICS PROGRAMS

SECOND CYCLE OF
SECONDARY SCHOOLS

May 1986

Québec

EDUQ 8770945

REARRANGEMENT OF THE CHEMISTRY AND PHYSICS PROGRAMS

SECOND CYCLE OF SECONDARY SCHOOLS

Direction générale des programmes
Direction de la formation générale

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Ministère de l'Éducation, 1986

ISBN 2-550-13347-1

Dépôt légal - troisième trimestre 1986

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INTRODUCTION

This document is to be used as a pedagogical guide to facilitate the application of the present chemistry and physics programs offered in secondary four and five.

The implementation of the regime pedagogique for secondary four and five is to take place successively in September 1986 and 1987. Since the new sciences programs are not available at the present time, the existing ones will be taught within the norms of the new regime pedagogique which recognizes 4 credits with a suggested teaching time of 100 hours, whereas initially, the guidelines were 150 teaching hours crediting successfull students with 2 units.

The present programs have undergone modifications as to the lenght of time and content during the course of previous years. Now they are once more revised in order to adapt them to today's educational standards.

To achieve the teaching of the program in 100 hours as suggested, this document indicates on the left hand side the 150 hours original version (except Science 412) and on the right hand side the 100 hours modified contents as proposed by the Ministry of Education of Quebec. It is believed that these suggestions will bring some sort of provincial uniformity and will help the teachers to adapt these programs to their students and to their local allotted time, whenever they are unable to teach the original program.

This guide pertains to the chemistry and physics programs locally evaluated. "Working units" have been provided for the programs subjected to ministerial exams. These were outlined in last December's "Modification to the 1985 Examination Bulletin - Chemistry and Physics". A letter accompanying the "1986 Examination Bulletin - Chemistry and Physics" explains the operating principles of these working units as well as the criteria used for their selection. Additional information on these programs are also included in this document.

SELECTION CRITERIA AND GUIDELINES FOR THE "WORKING UNITS"

The selection process of the "working units", that is the parts of the program which can be selected, are on the whole common to all of the programs. However the character of some of the criteria may vary at times depending upon the discipline (chemistry or physics) or the status of the program (terminal or not).

Some complete sections of the physics program could be optional since each of these sections is complete in itself and not necessarily dependent upon other units. Such is not the case in chemistry. The knowledge of certain basic elements of one section of the chemistry program is often a prerequisite to other sections.

In addition, as in the case of a program identified as necessary for advancement towards another program, some parts of one can be summarized and integrated into the other. This does not apply to terminal programs.

Basic criteria for the selection of the "working units"

Criteria concerning the general aspects of the program.

Lenght: To conform as much as possible to the allotted teaching time.

Difficulty Level: To keep some of the difficulties, specially those within Chemistry 462, 562 and Physics 452, 522. The teaching time is shortened but the student's abilities remain the same.

Repetition: To keep a variable range of subject matter written up in both secondary 4 and 5 when the two are usually chosen by the student(s). This criterion is specially difficult to apply for Chemistry 442 as it is often chosen as a terminal program.

Laboratory experiments: To retain subjects suitable for experimentation. The experimental method being necessary to the scientific formation of the young.

Logic: To keep within the logic of the program and allowing the rational use of existing didactic materials.

On the other hand these criteria take into consideration other aspects related to these programs, such as:

Prerequisites: To respect the prerequisites for further studies.

Information Bulletin: To abide by the decisions written up in the Examination Information Bulletin for programs subjected to ministerial exams.

Trends of future programs: To implement, as much as possible, changes relevant to the trends of future programs. For example, integrating the necessary mathematical tools for the acquisition of additional knowledge and the familiarization with the scientific method as a thinking process.

Guidelines for the "working units"

The teacher, by modifying the scope of the various working units, will enable the students to learn the program within the newly allotted time. The basis of these guidelines should be according to the following:

1. Assist the students to attain the essentials of these parts of the program.

2. Incorporate the notions included in these parts into other sections of the program as stepping stones or applications.

3. Introduce these notions as projects to be carried out by the students in the form of: research, discussions, field trips, surveys, etc.

4. Demonstrate certain laboratory experiments which are part of the "working units" instead of having them usually performed by the students.

5. Evaluated the working knowledge attained by the students through your teachings. No questions will be asked on the sections identified as "working units" on programs subjected to ministerial exams for the sake of fairness and uniformity. Teachers are responsible to evaluate these parts in the light of their teaching goals.

6. Be aware of the following ultimate principle: it is the responsibility of each teacher to adapt his teaching to his own personality, to the student's abilities and to the allotted time and material, etc. The directives included in this document are only guidelines to your teaching approach.

DETAILS REGARDING PROGRAMS SUBJECT TO MINISTERIAL EXAMS

The "Information Bulletin for the 1986 Exam (Chemistry, Physics)" contains more or less the same information, however more precise details could be of value.

Let us take for example, Chemistry 462. Chapter 1 of the official version of the program pertaining to "fundamental notions", is in fact a regrouping of the basic mathematical techniques and notions useful for acquiring further knowledge into the program. Therefore they can be incorporated into other parts of the program in such manner that they can be learned and evaluated at the opportune time.

Chapter 2, pertaining to the "Scientific Method" can also be treated in the same manner. This method is a processus by which a student progressively builds his knowledge of additional data. In evaluating the student, the teacher should not appraise the knowledge of the steps of the scientific method but the student's progress in the understanding of this thinking process.

It is then obvious, that no questions will be asked in the ministerial exam pertaining to chapters such as chapters 1 and 2. Consequently, the teacher must evaluate these parts which are not examined by the Ministry of Education of Quebec. Moreover, the pedagogical guide relative to this program (document 16-3139, part A) suggests on page 6 a way which these two chapters can be integrated to other notional elements.

You must take note that within these examination information bulletins, the word "optional" makes reference to the allotted time given, the pedagogical approach and the depth in which these subjects are learned. Let us refer once more to the chapters previously mentioned. We cannot ignore certain notions that these two convey. We can however teach them in less time, more superficially or integrate them within the studies of other notions or modify the proposed teaching strategy, etc. Then, considering the variety of approaches accorded to these "working units" the Ministry of Education of Quebec agreed not to evaluate these parts so as to be fair to the students.

CONTENT AND OBJECTIVES OF CHEMISTRY 442 PROGRAM

The objectives of Chemistry 270-442 listed in this document are outlined on the left side of the page. These objectives, taken from the pedagogical guide (document 16-3139 - Part A), suggested a teaching time between 120 to 150 hours. The objectives pertaining to the program 270-462 have been removed. This explains why some objectives are missing from the numerical order as we did not want to modify the original version of the pedagogical guide.

The right side of the page is a suggested guide aimed at teaching the essentials of the program over a period of 100 hours. Suggestions are given to regroup certain fundamentals in some sections, particularly sections 1.00 and 2.00. You will also notice that in some sections certain objectives are not repeated on the right handside of the page. These are not required fundamentals but are used for measurement whenever they are necessary to acquire additional knowledge or can be employed for program enrichment.

Comparing the modified versions of Chemistry 462 and Chemistry 442, you will notice, that some sections have become "working units" in program 462 whereas in Chemistry 442 they kept their original standing since it is often used as a terminal program. Such is the case for the chapter pertaining to acids and bases. It is believed that the difficulty level regarding these fundamentals is well adapted in program 442. Acids and bases form an important item to be integrated in the Chemistry program as it awakens the student's awareness on the subject in the context of everyday's experience. Acids and bases are identified as a "working unit" in Chemistry 462 and is also part of Chemistry 562 which is the natural progression of Chemistry 462. Some of these notions can also become part of the chapter on solutions.

To determine the "working unit", whether the nature of the program is terminal or not, we have always taken into consideration the selective criteria mentionned in the preliminary pages of this document. However it is up to the teachers to make modifications if necessary by using the suggested guide lines.

TOTAL TEACHING TIME 150 hours

1.00 FUNDAMENTAL NOTIONS

1.10 Fundamental concepts

1.11 Mass

1. Define mass
2. Name the base unit of mass

1.12 Volume

3. Define volume
4. Name the unit of volume

1.13 Density

5. Define density
6. Define density as a mass volume ratio
7. State the formula for density
8. State a unit of density
9. Identify, given a certain number of units, those which express:
   a) a mass
   b) a volume
   c) a density
10. Calculate from experimental data the density of:
    a) a solid
    b) a liquid
    c) a gas

TOTAL TEACHING TIME 100 hours

1.00 FUNDAMENTAL NOTIONS

1.10 Fundamental concepts

As shown in the pedagogical guide, these fundamentals will be taught on a need to know basis. Many of these fundamentals can be regrouped and may be the object of a laboratory or of a demonstration activity. For example: the determination of density (1.13) could be done as a laboratory experiment.

TOTAL TEACHING TIME 150 hours

1.20 Fundamental techniques

1.21 Measurement of: a) lenght
b) area

11. Measure:
a) the lenght of an object
b) the area of an object
c) the volume

12. Measure the volume of:
a) a solid
b) a liquid
c) a gas

13. Measure the mass of:
a) a solid
b) a liquid
c) a gas

1.22 Instrument reading

14. Read the measuring instruments usually found in a laboratory.

1.23 Formulate an operational definition and carry out the techniques of:

15. 16. sedimentation, sedimenting
17. 18. decantation, decanting
19. 20. filtration, filtering
21. 22. centrifugation, centrifuging
23. 24. precipitation, precipitating
25. 26. dilution, diluting
27. 28. distillation, distilling
29. 30. crystallization, crystallizing
31. 32. dissolution, dissolving.

TOTAL TEACHING TIME 100 hours

1.20 Fundamental techniques

As mentionned in the pedagogical guide, these fundamentals will be taught on the need to know basis. Many of these fundamentals can also be regrouped and may be the object of a laboratory or a demonstration activity. For example: the various separation techniques (1.23) can be demonstrated. To this, section 3.22 of unit 3, could be included and inversely section 1.23 of unit 1 could be included in unit 3.

TOTAL TEACHING TIME 150 hours

1.30 Mathematics fundamentals

1.31 Algebraic operations

33. Solve for a variable in an algebraic expression.
34. Calculate the value of a variable given the value of the others.

1.32 Scientific notation
(ref.:Doc.16-3136 1976 edition)

35. Convert a number expressed as a decimal into an exponential expression and vice-versa. (1 whole 10)
36. Add, subtract, multiply, divide decimals.

1.33 Exponents

37. Multiply, divide exponential expressions.

1.34 Ratio and proportion

39. Solve ratio and proportion problems expressed as whole numbers or simple fractions

1.35 Percentage calculations

40. Calculate percentages
41. Calculate the masses of the elements in a substance, given its percentage composition.

1.36 Construction of graphs

42. Construct properly a graph from a table of data.

1.37 Interpretation of graphs

43. Interprete a graph.

TOTAL TEACHING TIME 100 hours

1.30 Mathematics fundamentals

The necessary mathematical operations can be integrated whenever they become necessary in the acquisition of additional knowledge.

TOTAL TEACHING TIME 150 hours

2.00 THE SCIENTIFIC METHOD *

2.10 Description of the scientific method

1. Define "observation".
2. Define "interpretation".
3. Observe and describe a given object.
4. Identify, given a description, the qualitative observations, the quantitative observations and the interpretations.
5. Distinguish from a table of data a common factor or state a generalization.
8. Express data based on two variables:
   a) qualitatively, as a statement describing the relationship.
   b) quantitatively, as a table summarizing the information given.
   c) graphically.
   d) mathematically, as a formula.

* The program (page 10) suggests a choice of steps in the scientific method less selective and stereotyped than those ordinarily found in the student's texts. It is left to the teacher to explore the proper steps in different situations proposed to the student. These objectives constitute a minimum requirement.

TOTAL TEACHING TIME 100 hours

2.00 THE SCIENTIFIC METHOD *

2.10 Description of the scientific method

In the acquisition of knowledge, the scientific method should be emphasized as a process to be developed (insist on using the stages which are suitable to the student group).

* The program (page 10) suggests a choice of steps in the scientific method less selective and stereotyped than those ordinarily found in the student's texts. It is left to the teacher to explore the proper steps in different situations proposed to the student. These objectives constitute a minimum requirement.

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

2.20 Uncertainty

2.21 Sources of error:
a) human
b) instrument

9. Determine correctly the absolute error in reading a meter stick, a balance, a graduated cylinder, a thermometer, etc.

2.22 Expression of the error
a) in readings

10. Express absolute error using the proper number of significant digits or using the notation (+ or -) (Ref. Doc.16-3136 1976 edition)

b) in computations

11. State the rules of uncertainty governing the addition and subtraction of measured quantities.
13. Express, using the symbol (±), the error of measurement obtained from additions and subtractions.

TOTAL TEACHING TIME 150 hours

3.00 MATTER *

3.10 States **, properties and changes in matter

3.11 State(s)

1. Distinguish among the three states of matter from their respective properties.

3.12 Physical and chemical properties

2. Identify, from a list of properties of matter, those that are:
   a) physical properties
   b) chemical properties

3.13 Physical and chemical changes

3. Identify from a list of changes those which are:
   a) physical changes
   b) chemical changes

* The operational nature of this unit is directed to the students of course 442 and 462. Instead of studying the content of the unit in a systematic way, teachers might find it beneficial to reintroduce the topics in other sections of the program and insure that the students have achieved the objectives.

** Some authors use "states" and "phases" with different meanings; in this document the word "phase" will mean the homogeneous part of a system.

TOTAL TEACHING TIME 100 hours

3.00 MATTER *

3.10 States **, properties and changes in matter

3.11 State(s)

1. Distinguish among the three states of matter from their respective properties.
Note: With the aid of suitable models represent the three states of matter.(see 4.10)

3.12 Physical and chemical properties

2. Identify, from a list of properties of matter, those that are:
   a) physical properties
   b) chemical properties

3.13 Physical and chemical changes

3. Identify from a list of changes those which are:
   a) physical changes
   b) chemical changes

* The operational nature of this unit is directed to the student of course 442 and 462. Instead of studying the content of the unit in a systematic way, teachers might find it beneficial to reintroduce the topics in other sections of the program and insure that the students have achieved the objectives.

** Some authors use "states" and "phases" with different meanings; in this document the word "phase" will mean the homogeneous part of a system.

TOTAL TEACHING TIME 150 hours	TOTAL TEACHING TIME 100 hours
4. Describe the following physical changes: fusion, solidification, vaporization, condensation and sublimation. 5. State two differences between a physical and chemical change	4. Describe the following physical changes: fusion, solidification, vaporization, condensation and sublimation. Note: Within this section one could add objective 37 and 38 of unit 6. In order to elicit interest, one may use everyday examples in order to illustrate these changes.
3.20 Macroscopic classification of matter.	3.20 Macroscopic classification of matter. Note: The classification of matter may be illustrated by means of a table.
3.21 Definitions	3.21 Definitions
6. Define a "system" 7. Define a "phase" 8. Define "homogeneous substance" in terms of phases. 9. Define "heterogeneous substance" in terms of phases.	8. By means of a concrete operation define a "homogeneous substance". 9. By means of a concrete operation define a "heterogeneous substance".
3.22 Mixtures	3.22 Mixtures
10. Separate the constituents of a mixture using appropriate means. 11. List 3 characteristics of a mixture.	10. Separate the constituents of a mixtures using appropriate means.

TOTAL TEACHING TIME 150 hours

3.23 Solutions

12. Define "solution" in terms of phase.
13. State 3 properties of solutions.
14. Distinguish between a solution and a mixture in terms of phase.

3.24 Pure substances: a) compounds
b) elements

15. Determine experimentally the melting or boiling temperature of a pure substance.
16. Formulate the definition of a pure substance.
17. Identify 3 characteristics of a pure substance.
18. Distinguish between a pure substance and a solution in terms of proportions.
19. Distinguish a pure substance from a mixture.
20. Formulate a definition for a chemical compound.
21. Identify 2 characteristics of compounds.
22. By means of a concrete operation define an "element".
23. By means of a concrete operation distinguish an element from a compound.
24. Distinguish a compound from a mixture.
25. State the "law of definite proportions".
26. Explain the "law of definite proportions".

TOTAL TEACHING TIME 100 hours

3.23 Solutions

12. By means of a concrete operation define a "solution".

3.24 Pure substances: a) compounds
b) elements

15. Determine experimentally the melting or boiling temperature of a pure substance.
16. Formulate the definition of a pure substance.
17. Identify 3 characteristics of a pure substance.
19. Distinguish a pure substance from a mixture
20. Formulate a definition for a chemical compound.
21. Identify 2 characteristics of compounds.
22. By means of a concrete operation define an "element".
23. By means of a concrete operation distinguish an element from a compound.
24. Distinguish a compound from a mixture.

TOTAL TEACHING TIME 150 hours

3.30 Energy

3.31 Forms

27. List some forms of energy.
28. State the definition of "potential energy".
29. State the definition of "kinetic energy".

3.32 Observation

30. Describe some examples of conservation of energy.
31. State the formula expressing the relationship between matter and energy.

3.33 Chemical

32. State the definition of "endothermic reaction".
33. State the definition of "exothermic reaction".
34. Identify, given a thermal equation, an exothermic or endothermic reaction.

3.34 Comparisons

35. Arrange qualitatively in order of increasing relative importance, the quantities of energy associated with the following changes:
    a) physical changes
    b) chemical changes
    c) nuclear changes

TOTAL TEACHING TIME 100 hours

3.30 Energy

3.31 Forms

27. List some forms of energy.
28. State the definition of "potential energy".
29. State the definition of "kinetic energy".

3.32 Observation

30. Describe some examples of conservation of energy.
31. State the formula expressing the relationship between matter an energy.

3.33 Chemical

32. State the definition of "endothermic reaction".
33. State the definition of "exothermic reaction".
34. Identify, given a thermal equation, an exothermic or endothermic reaction.

Note: Objectives 32, 33, 34 may be integrated into unit 5.

TOTAL TEACHING TIME 150 hours

4.00 ATOMIC THEORY

4.10 Characteristics of a model

6. Formulate a definition of the concept "model".

4.20 The particle model of matter

7. Formulate from the observed behaviour of gases an hypothesis of the particulate or molecular nature of matter.

4.21 Avogadro's hypothesis

9. State Avogadro's hypothesis.
10. Determine quantitatively the ratio of two reacting volumes of gases.
11. Explain the simple ratios of reacting gases using Avogadro's hypothesis.

4.22 Molecules and atoms

12. State the definition of the atom.

4.24 Molecular models

16. Construct models of molecules already studied.

TOTAL TEACHING TIME 100 hours

4.00 ATOMIC THEORY

4.10 Characteristics of a model

6. Formulate a definition of the concep: "model".

Note: This objective may be placed whith objective 1 of unit 3.

4.22 Molecules and atoms

12. State the definition of an atom and of a molecule.

4.24 Molecular models

16. Construct models of molecules already studied.

Note: State the definition of the concept elements and compounds.

TOTAL TEACHING TIME 150 hours

4.25 Symbols and formulas

17. Write the chemical symbols of the first 18 elements.
18. Name the first 18 elements given their symbol.
19. Write the formula of a familiar compound given its name.
20. Write the name of a familiar compound given its name.
21. Identify the number of each kind of atoms present in a molecular formula.

4.26 Formulas: molecular and structural

22. Formulate a definition of molecular formula.
23. Formulate a definition of structural formula.
24. Distinguish between molecular and structural formulas.

4.27 Mole and Avogadro's number

25. Formulate a definition of the mole.
26. Establish the correlation between the mole and Avogadro's number. (N_A)

4.28 Molar masses: a) of molecules
b) of atoms

27. Formulate a definition of relative molar mass.
28. Formulate a definition of molecular mass.
29. Formulate a definition of molecular molar mass.
30. Distinguish between molar mass of a molecule and molecular mass.

TOTAL TEACHING TIME 100 hours

4.25 Symbols and formulas

17. Write the chemical symbols of the first 18 elements
18. Name the first 18 elements given their symbol.
19. Write the formula of a familiar compound given its name.
20. Write the name of a familiar compound given its name.
21. Identify the number of each kind of atoms present in a molecular formula.

4.26 Formulas: molecular and structural

22. Formulate a definition of molecular formula.
23. Formulate a definition of structural formula.
24. Distinguish between molecular and structural formulas.

4.27 Mole and Avogadro's number

25. Formulate a definition of the mole.
26. Establish the correlation between the mole and Avogadro's number.(N_A)

4.28 Molar masses: a) of molecules
b) of atoms

29. Formulate a definition of molecular molar mass.

TOTAL TEACHING TIME 150 hours

31. Formulate a definition of the mass of a mole of atoms.

32. Distinguish between molar mass of an atom and atomic mass.

33. Calculate the molar mass of molecules of a substance given its formula and a table of molar mass of atoms.

35. Calculate given the formula of a substance:

a) the number of moles corresponding to a given mass of this substance and vice-versa.
b) the number of molecules present.
c) the number of moles of each kind of atoms present.

4.29 Relative molar mass of molecules

36. Determine experimentally and compare the masses of equal volume of several different gases.

TOTAL TEACHING TIME 100 hours

31. Formulate a definition of the mass of a mole of atoms.

33. Calculate the molar mass of molecules of a substance given its formula and a table of molar mass of atoms.

TOTAL TEACHING TIME 150 hours

5.00 CHEMICAL REACTIONS AND STOICHIOMETRY

5.10 Chemical reactions.

1. State 3 ways of identifying a chemical change.
2. Formulate a conceptual definition of a chemical change.
3. State two fundamental hypothesis as enunciated by the atomic theory to explain the characteristic properties of individual substances.

5.20 Chemical equations.

5.21 Writing equations.

4. Given a word equation, write a chemical equation.
5. Describe the changes in a given chemical equation by indicating the substance present, the number of atoms in each molecule and the number of molecules of each substance taking part in the reaction.
6. Given a chemical equation, identify the reactants and the products.

5.22 Balancing equations.

7. Balance simple chemical equations taking into account these principles:
   a) conservation of mass
   b) conservation of atoms
   c) non-conservation of molecules

TOTAL TEACHING TIME 100 hours

5.00 CHEMICAL REACTIONS AND STOICHIOMETRY

5.10 Chemical reactions.

1. State 3 ways of identifying a chemical change.
2. Formulate a conceptual definition of a chemical change.

5.20 Chemical equations.

5.21 Writing equations.

4. Given a word equation, write a chemical equation.
5. Describe the changes in a given chemical equation indicating the substance present, the number of atoms in each molecule of the number of molecules of each substance taking part in the reaction.
6. Given a chemical equation, identify the reactants and the products.

5.22 Balancing equations.

7. Balance simple chemical equations taking into account these principles:
   a) conservation of mass
   b) conservation of atoms
   c) non-conservation of molecules

TOTAL TEACHING TIME 150 hours

5.23 Calculations

8. Calculate, given a balanced chemical equation, stoichiometric quantities involving the following conversions or proportions:

a) mass ——— mass
b) mass ——— mole
c) mole ——— mole

5.30 Law of conservation

5.31 Of mass

9. State the law of conservation of mass from experimental data.
10. Apply the law of conservation of mass to the solution of problems having for an unknown the mass of a reactant or a product.

5.32 Of energy

a) principle of proportionality

11. State a principle concerning the relationship between the quantity of reactant and the quantity of energy liberated or absorbed.
a) during a change of state
b) during a chemical reaction

TOTAL TEACHING TIME 100 hours

5.23 Calculations

8. Calculate, given a balanced chemical equation, stoichiometric quantities involving the following conversions or proportions:

a) mass ——— mass

c) mole ——— mole

5.30 Law of conservation

5.31 Of mass

9. State the law of conservation of mass from experimental data.
10. Apply the law of conservation of mass to the solution of problems having for an unknown the mass of a reactant or a product.

5.32 Of energy

a) principle of proportionality

11. State a principle concerning the relationship between the quantity of reactant and the quantity of energy liberated or absorbed.
a) during a change of state
b) during a chemical reaction

TOTAL TEACHING TIME 150 hours

b) principle of reversibility

12. Compare the quantity of energy liberated by a given mass of substance during a change of state, to the quantity of energy absorbed by the same mass of this substance during a reverse change of state

13. Compare the quantity of energy liberated by a given mass of substance, when it is formed, to the quantity of energy absorbed by the same mass of this substance when it is decomposed.

14. Deduce from the 2 comparisons above a principle of energetics

TOTAL TEACHING TIME 100 hours

Note: Within this section one could integrate objectives 32, 33, 34 of unit 3.

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

6.00 THE KINETIC MOLECULAR THEORY OR MATTER

6.10 The Gas Phase

6.11 Pressure:
a) barometers and manometers
b) reference pressure
c) partial pressure
d) Boyle's law

1. Define the pressure of a gas as a function of the number of collisions.

2. Explain the principle of the mercury and aneroid barometers.

4. Read on the mercury barometer, or a diagram of the same, the atmospheric pressure.

6. Formulate the definition of "reference pressure".

9. State qualitatively and mathematically the pressure-volume relationship of a gas.

10. Construct and interprete a graph of the volume of a gas as a function of its pressure.

11. Identify, among a number of graphs, one which describes the pressure-volume relation of a gas.

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

12. Apply the pressure-volume relationship to the solution of problems where either the pressure or the volume will vary at constant temperature.

6.12 Temperature

a) Definition

13. Distinguish between temperature and heat.

b) Reference temperature

14. State a definition of "reference temperature".

c) Absolute temperature

15. Construct and interprete a graph of the pressure of a gas as a function of its temperature.
16. Determine the temperature at which the pressure becomes zero.
17. State qualitatively and mathematically the pressure-temperature relationship of a gas.
18. Apply the pressure-temperature relationship of a gas to the solution of problems where the temperature varies at constant volume.

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

d) Celsius and Kelvin scales

20. Convert the readings of the Celsius scale to the Kelvin scale and vice versa.

e) Charle's law

21. Construct and interprete a graph of volume of a gas as a function of its temperature.
22. State qualitatively and mathematically the volume-temperature relationship of a gas.
23. Apply the relation volume-temperature (Charle's law) to the solution of problems where the temperature (K) varies at constant pressure.

6.13 Molar Volume

26. Determine experimentally the approximate value of the molar volume of a gas at room conditions, using a method that will eliminate corrections for volume due to temperature and pressure.
28. Define the molar volume of a gas.
30. Calculate, given a balanced chemical equation, the stoichiometric quantities involving the following conversions:

mass ——————— volume
volume ——————— volume
volume ——————— mole

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

6.14 The kinetic molecular theory

32. State the main points of the kinetic molecular theory.
33. Explain the states of matter in terms of the kinetic molecular theory.
34. Rank the velocity of different gases according to their respective molecular sizes.
35. State the relationship between the kinetic energies of molecules of different gases at a given temperature.

6.20 Changes of states

37. Construct, from experimental data, a graph showing the heating of a pure substance.
38. Identify correctly from the heating curve of a pure substance the melting and boiling temperatures.
39. Write an equation involving a change of state.
40. Read an equation involving a change of state.

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

6.21 Solid ——— liquid:

a) Heat of fusion

41. State the definition of "joule".
42. State the definition of "heat of fusion".
43. Determine experimentally and mathematically the heat of fusion of a substance.
48. State a hypothesis that would explain temperature remaining constant during a change of state.

b) Heat of solidification

49. State the definition of the heat of solidification.

6.22 Liquid ——— Gas

a) Heat of vaporization
Heat of condensation

51. State the definition of heat of vaporization.
52. State the definition of heat of condensation.
53. Calculate the energy required to vaporize or condense a given mass of substance, knowing its heat of vaporization or condensation.

b) Evaporation/boiling

57. Distinguish between evaporation and boiling.

TOTAL TEACHING TIME 150 hours

7.00 THE SOLUTIONS

7.10 Solubility

1. Formulate an operational definition of "solubility".
2. Distinguish between a solvent and a solute.
3. State 2 factors which influence solubility.
4. Describe the effect of the solvent and solute on the solubility of a substance.
5. Describe the effect of temperature on the solubility of solids in a liquid and of gases in a liquid.
6. Given a graph of the solubility of several substances, identify the most soluble and least soluble solute.
7. Describe:
   a) a saturated solution
   b) an unsaturated solution
8. Prepare:
   a) a saturated solution
   b) an unsaturated solution

7.11 Dissolution

9. State the different combinations of solvents and solutes able to form solutions.
10. Explain the solubility-temperature graph of a solid.

TOTAL TEACHING TIME 100 hours

7.00 THE SOLUTIONS

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2. Distinguish between a solvent and a solute.
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9. State the different combinations of solvents and solutes able to form solutions.
10. Explain the solubility-temperature graph of a solid.

TOTAL TEACHING TIME 150 hours	TOTAL TEACHING TIME 100 hours
7.20 Molar concentration (molarity)	7.20 Molar concentration (molarity)
11. Formulate a definition of "molar concentration".	11. Formulate a definition of "molar concentration"
12. Prepare different types of solid-liquid and liquid-liquid solutions of different molar concentrations.	
13. Explain the formula that expresses the concentration of a solution.	13. Explain the formula that expresses the concentration of a solution.
14. Calculate the molar concentration of a solution, given the volume of the solution, the number of moles of slute or its mass in grams and vice-versa.	
7.21 Known concentration expressions (ref. Metric Style Guide Sec. 574)	7.21 Know concentration expressions (ref. Metric Style Guide Sec. 574)
15. State everyday situations where the following concentration expressions are used: a) Mass/volume b) Mass/mass c) Volume/volume d) a,b,c, above expressed as percentages (%)	15. State everyday situations where the following concentration expressions are used: a) Mass/volume b) Mass/mass c) Volume/volume d) a,b,c, above expressed as persentages (%)
7.40 Properties	7.40 Properties
7.41 Electrical conductibility of solutions	7.41 Electrical conductibility of solutions
18. Formulate the definition of electrolyte and non-electrolyte.	18. Formulate the definition of electrolyte and non-electrolyte.

TOTAL TEACHING TIME 150 hours

19. Distinguish between electrolyte and non-electrolyte.
20. Formulate a definition of anode, cathode, cation and anion. (ref: 8.10)

7.42 Electrolysis

21. State an operational criteria to distinguish between a weak and a strong electrolyte.
22. Formulate an hypothesis to explain the difference in conductivity between a strong and weak electrolyte.
23. State 3 factors responsible for the electrical conductivity of solutions.

7.43 Precipitation reactions in aqueous solutions

24. Recognize the formation of a precipitate.
25. Balance an ionic equation using a table of common ions and the conservation of charge principle.
30. Calculate, given the concentration of an ionic solute, the concentration of ions present in an aqueous solution of this solute.

TOTAL TEACHING TIME 130 hours

19. Distinguish between electrolyte and non-electrolyte.
20. Formulate a definition of cation and anion. (ref: 8.10)

7.42 Electrolysis

21. State an operational criteria to distinguish between a weak and a strong electrolyte.
22. Formulate an hypothesis to explain the difference in conductivity between a strong and weak electrolyte.
23. State 3 factors responsible for the electrical conductivity of solutions.

7.43 Precipitation reactions in aqueous solutions

24. Recognize the formation of a precipitate.

TOTAL TEACHING TIME 150 hours

8.00 STRUCTURE OF THE ATOM AND THE PERIODIC TABLE

8.10 Model of the nuclear atom

1. Describe Thompson's atomic model.
2. Describe Rutherford's nuclear atomic model.
3. Determine the nature of:
   a) the charge of the electron
   b) the charge of the proton
4. State the definition of "ion".
5. State the definition of a "neutral body".
6. Formulate hypotheses on the attraction or repulsion of electrically charged bodies.
7. Construct a graph of electrostatic force as a function of distance, given a number of values of the variable "r".

8.20 Characteristics of the nuclear atom

8.21 Mass of an atom and its constituents

9. Define the following by stating two properties:
   a) electron
   b) proton
   c) neutron

TOTAL TEACHING TIME 100 hours

8.00 STRUCTURE OF THE ATOM AND THE PERIODIC TABLE

8.10 Model of the nuclear atom

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2. Describe Rutherford's nuclear atomic model.
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5. State the definition of a "neutral body".
6. Formulate hypotheses on the attraction or repulsion of electrically charged bodies.

8.20 Characteristics of the nuclear atom

8.21 Mass of an atom and its constituents

9. Define the following by stating two properties:
   a) electron
   b) proton
   c) neutron

Note: Distinguish quantitatively the order of magnitude of the mass of the proton, of the neutron and of the electron.

TOTAL TEACHING TIME 150 hours

8.22 The size of atoms

11. Distinguish the order of magnitude between the diameter of the atom and that of the nucleus.

8.23 Atomic number

12. Formulate the definition of atomic number.

8.24 Mass number

13. Formulate a definition of mass number or the number of nucleons.

8.25 Isotopes

14. State the definition of "isotopes".
15. Indicate the number of protons, neutrons and electrons of a given isotope of an element of known mass number and atomic number.
16. State some fields of application for the isotopes of certain elements (I, Co, P, Na)

8.26 Nuclear reactions

17. Describe a nuclear reaction.
18. Write correctly a balanced nuclear reaction.

TOTAL TEACHING TIME 100 hours

8.23 Atomic number

12. Formulate the definition of atomic number.

8.24 Mass number

13. Formulate a definition of mass number or the number of nucleons.

8.25 Isotopes

14. State the definition of "isotopes".
15. Indicate the number of protons, neutrons and electrons of a given isotope of an element of known mass number and atomic number.

16. State some fields of application for the isotopes of certain elements (I, Co, P, Na)

8.26 Nuclear reactions

17. Describe a nuclear reaction

Note: One may take advantage of this section so as to discuss the controversy over nuclear energy.

TOTAL TEACHING TIME 150 hours

8.30 Chemical families and periodicity

19. State the definition of "periodicity".
20. Associate periodicity with the periodic numbers 2, 8, 18.
21. State the periodic law.

8.31 Classification

22. Distinguish between metals and non-metals from their physical properties.
23. Define "chemical families" in terms of chemical activities.
24. Identify the noble gases, the alkali and the halogens by their position in the periodic table.
25. State the definition of "period".

8.32 Periodic properties
a) chemical activity
b) atomic volume
c) electronegativity
d) ionization energy

26. List the properties by which you identify a family (group) or a period of the periodic table.
27. State the definition of "electronegativity".
29. State the trend in the following properties for a given family (group) in the periodic table
a) melting point
b) boiling point
c) chemical activity
d) electronegativity
e) atomic volume

TOTAL TEACHING TIME 100 hours

8.31 Classification

22. Distinguish between metals and non-metals from their physical properties.
23. Define "chemical families" in terms of chemical activities.
24. Identify the noble gases, the alkali and the halogens by their position in the periodic table.
25. State the definition of "period".

TOTAL TEACHING TIME 150 hours

9.00 CHEMICAL BONDING

9.10 Electron configuration

9.11 Electron shells and energy levels.

1. Formulate a definition of "electron shell".
2. Formulate a definition of "energy level".
3. Determine the basic electron structure (Bohr model) of the atoms of the first 20 elements.

9.20 Stability principles

4. State an hypothesis to explain the stability of the noble gases.
5. Compare the electron behaviour of atoms of elements in groups 1,2,6 and 7 (in particular) to the stable model of the noble gases.
6. Distinguish between the electron configuration of the elements of families 1,2,...6,7 and the nearest noble gas.
7. Determine each charge associated with the ions of the elements of these particular groups.
8. Write the formula of the halides, oxides and hydrides of each of the first (20) elements, knowing the group to which each element belongs.

9.30 Valence electrons

9. Formulate a definition of "valence electron".

TOTAL TEACHING TIME 100 hours

9.00 CHEMICAL BONDING

9.10 Electron configuration

9.11 Electron shells and energy levels.

1. Formulate a definition of "electron shell".
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7. Determine each charge associated with the ions of the elements of these particular groups.

9.30 Valence electrons

9. Formulate a definition of "valence electron".

TOTAL TEACHING TIME 150 hours

10. Calculate, given the atomic number of an element, the number of valence electrons in this element.
11. Depict, using Lewis'structures, the valence electrons of the first 20 elements.
12. Predict, knowing the group to which an element belongs,
    a) its probable physical properties.
    b) the formula of its hydride, oxyde and halide.
    c) the number of electrons involved in simple chemical reactions.

9.40 Chemical bonds

9.41 Ionic

13. Define ionic bond in terms of the difference in electronegativity.

9.42 Covalent

14. Define covalent bond in terms of the difference in electronegativity.
15. Depict these 2 types of bonds using Lewis'structures.
16. State 2 methodes of attaining the noble gas structure in a system of 2 or more atoms.

TOTAL TEACHING TIME 100 hours

10. Calculate, given the atomic number of an element, the number of valence electrons in this element.
11. Depict, using Lewis'structures, the valence electrons of the first 20 elements.
12. Predict, knowing the group to which an element belongs,
    a) its probable physical properties.
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14. Define covalent bond in terms of the difference in electronegativity.
15. Depict these 2 types of bonds using Lewis'structures.

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

20. Predict the eventual type of bond (ionic, covalent) between two atoms based on the difference in electronegativity.

21. Identify the Lewis structures of the halides and oxides of the first 20 elements, including the possible homonuclear structures.

22. Identify examples of single, double and triple bonds.

9.50 Molecular geometry

23. Construct, using commercial models, a minimum of 2 molecules for each of the following molecular shapes:
    a) linear
    b) angular
    c) triangular planar
    d) pyramidal
    e) tetrahedral

24. Identify from a group of molecules, a given molecular structure.

TOTAL TEACHING TIME 150 hours

10.00 ACIDS AND BASES

10.10 Properties of acids and bases

1. Formulate an operational definition of an "acid".
2. Formulate an operational definition of a "base".

10.20 Explanation of the properties of acids and bases

3. Formulate a conceptual definition of an acid and a base according to the theory of Arrhenius.
4. Write equations of ionization of acid or base according to this theory.
5. Write the ionic equation for the decomposition of water using acqueous ions.
6. Indicate the concentration of H^+ and OH^- ions in pure water.
7. Distinguish operationally between a strong and weak acid.

10.22 Neutralization

9. Describe in a few words the chemical reaction between an acid and a base.
10. Write a net ionic reaction for the neutralization reaction.
11. Recognize a neutralization reaction.

TOTAL TEACHING TIME 100 hours

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9. Describe in a few words the chemical reaction between an acid and a base.
10. Write a net ionic reaction for the neutralization reaction.
11. Recognize a neutralization reaction.

TOTAL TEACHING TIME 150 hours

10.30 The pH scale

13. Associate a H^+ ion concentration of 10^{-1} mol/l with a pH of 1.
14. Determine the pH of a solution given the H^+ ion concentration.
15. Determine the H^+ concentration of a solution from its pH.
16. Establish a parallel between the H^+ ion concentration scale (10^{-1} to 10^{-14}) or the pH scale (1 to 14) and the acidic, basic and neutral character of a solution.
17. Determine the character of a solution (acidic, basic or neutral) from its H^+ ion concentration or its pH.
18. Describe several simple systems where the pH control plays an important role.

10.40 Indicators

19. Identify, using indicators, the acidic or basic character of certain household products.
20. State some household indicators.

TOTAL TEACHING TIME 100 hours

10.30 The pH scale

16. Establish a parallel between the pH scale (1 to 14) and the acidic, basic and neutral character of a solution.

17. Determine the character of a solution (acidic, basic or neutral) from its pH.

18. Describe several simple systems where the pH control plays an important role.
(example: acid rain)

10.40 Indicators

19. Identify, using indicators, the acidic or basic character of certain household products.
20. State some household indicators.

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

11.00 ENVIRONMENTAL CHEMISTRY

11.10 General considerations on the environment

a) equilibria and the natural cycles

1. Formulate the definition of "community"
2. Formulate the definition of "food pyramid"
3. Describe, using an example, the interdependence of the factors of nutrition, reproduction and protection which unite together the members of a community.
4. Describe how the numerical balance is maintained in a community over a long period of time.
5. Describe the equilibrium in the relationship: organism ——— milieu
6. Describe the influence of the specialization of species and communities on the environment.

b) the natural cycles

7. State the 3 major subdivisions of the environment.
8. Describe the water cycle.
9. Describe the rock cycle of mineral substances.
10. Describe and draw a diagram of the contribution of each of the 5 subdivisions of the environment to the nutrition of living beings.

TOTAL TEACHING TIME 150 hours

c) chemical cycles

11. Describe and draw a diagram of the oxygen cycle.
12. Describe and draw a diagram of the carbon cycle.
13. Describe and draw a diagram of the nitrogen cycle.
14. Describe the importance of bacteria in the nitrogen cycle.
15. Describe the part played by the decomposition of dead organisms in the atmospheric, lithospheric and hydrospheric cycles.

11.12 Pollution

16. State 4 characteristics of pollution.
17. Describe the horizontal dimensions of pollution.
18. Explain th fundamental vertical dimensions of pollution.

11.13 Effects of pollution

a) social values

19. State 3 effects of pollution on social values.

b) economic values

20. State 3 effects of pollution on economic values.

Note: The next section carries a choice of one of 3 topics 11.20, 11.30 or 11.40

TOTAL TEACHING TIME 100 hours

Note: The next section carries a choice of one of 3 topics 11.20, 11.30 or 11.40

TOTAL TEACHING TIME 150 hours

11.20 Atmospheric environment

11.21 Natural composition of the air

21. Express in percentages the relative abundance of the constituents of clean dry air.
22. Establish the biological importance of air in the respiration process.
23. State 3 physical properties, 3 chemical properties and 3 uses of oxygen.
24. State 3 physical properties, 3 chemical properties and 3 uses of nitrogen.

11.22 Atmospheric pollutants

a) nature

25. State 10 types of atmospheric pollutants.

b) sources

26. Identify two sources for each of these types of pollutants.

c) effects

27. Determine for each of these types of pollutants the effect on:
a) living beings
b) plants
c) materials

TOTAL TEACHING TIME 100 hours

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c) effects

27. Determine for each of these types of pollutants the effect on:
a) living beings
b) plants
c) materials

TOTAL TEACHING TIME 150 hours

d) detection

28. Describe a detection method appropriate to each type of pollutants.
29. State 2 natural means of autopurification of the air.
30. State some artificial means of purifying the air.
31. State two different expressions for describing the concentration of pollutants.
32. Distinguish between minimum accepted concentration and critical concentration.
33. List the critical concentrations of the 10 types of pollutants already mentioned.

11.23 Personal "anti-pollution" contribution

34. Identify 5 personal social customs as source of air pollution.
35. Identify 5 ways of personal contribution to air purification.

11.30 The acquatic environment (hydrosphere)

11.31 Importance of water resources

a) uses

36. Describe, using examples, the many uses of water.
37. Estimate the average amount of water consumption for industrial and domestic use in liters per person per day.

TOTAL TEACHING TIME 100 hours

d) detection

28. Describe a detection method appropriate to each type of pollutants.
29. State 2 natural means of autopurification of the air

30. State some artificial means of purifying the air.
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a) uses

36. Describe, using examples, the many uses of water.
37. Estimate the average amount of water consumption for industrial and domestic use in liters per person per day.

TOTAL TEACHING TIME 150 hours

b) current and future needs

38. Describe briefly the influence of the following 5 factors on the future demands of water: population, nature of the economy, technology, social habits and government decisions.

c) current and future availability

39. Evaluate statistically and from a critical point of view, the amount of available water in Quebec in billions of litres in comparison to the needs (in 1980) in billions of litres per year.

11.32 Natural composition of water

a) natural constituents

40. State the main substances found in river water.
41. State the reagent used to detect the following ions: Ca^{2+}, Cl^{-}, Mg^{2+}, CO_3^{2-}
42. Describe a method of measuring qualitatively the concentration of O_2 in water.
44. Distinguish between "natural" and "chemically" pure water.
45. Distinguish between hard and soft water.

TOTAL TEACHING TIME 100 hours

b) current and future needs

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44. Distinguish between "natural" and "chemically" pure water.
45. Distinguish between hard and soft water.

TOTAL TEACHING TIME 150 hours

b) properties and composition of domestic water

47. State some properties of drinking water.

11.33 Water pollutants

a) nature

49. State 10 kinds of water pollutants

b) sources

50. Identify for each of these kind of pollutants 2 domestic or 2 industrial sources.

c) effects

51. Determine for each of these kinds of pollutants its effects on:
a) living beings
b) plants
c) ecology
d) materials

d) detection and norms

52. Describe a method of detection appropriate to each of these kinds of pollutants.

53. State certain criteria or norms for the disposal of refuse.

54. Classify polluted and non-polluted water on the basis of these criteria.

TOTAL TEACHING TIME 100 hours

b) properties and composition of domestic water.

47. State some properties of drinking water.

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a) nature

49. State 10 kinds of water pollutants

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53. State certain criteria or norms for the disposal of refuse.

54. Classify polluted and non-polluted water on the basis of these criteria.

TOTAL TEACHING TIME 150 hours

e) purification and control
- by natural means
- by artificial means

55. State 2 natural means of auto-purification of water.
56. Describe, as examples of artificial means of purification of water:
a) 4 physical methods
b) 6 chemical methods
57. Distinguish between the chemical properties of $F_2(g)$ and $F^-(aq)$.
58. Name certain compounds of chlorine and fluorine suitable for the chemical treatment of water.

11.34 Personal "anti-pollution" contribution

59. Identify 5 personal habits as sources of water pollution.
60. Describe a five point program of action as one's contribution to water purification.

11.40 Terrestrial environment (lithosphere)

11.41 Pollutants

a) nature

61. Distinguish between organic and inorganic types of pollutants.

TOTAL TEACHING TIME 100 hours

e) purification and control
- by natural means
- by artificial means

55. State 2 natural means of auto-purification of water.

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11.40 Terrestrial environment (lithosphere)

11.41 Pollutants

a) nature

61. Distinguish between organic and inorganic types of pollutants.

TOTAL TEACHING TIME 150 hours

b) sources

62. Distinguish between biogradable and elementary substances.
63. State 5 examples of domestic or industrial pollutants.

c) purification

64. State 3 methods of control of terrestrial pollution caused by solid waste.
65. Discuss the relative merits of each of these methods.

11.42 Personal "anti-pollution" contribution

66. Identify 5 personal social habits that contribute to pollution.

67. Describe an anti-pollution program containing 10 ways of limiting one's contribution to pollution caused by solid waste.

TOTAL TEACHING TIME 100 hours

b) sources

62. Distinguish between biogradable and elementary substances.
63. State 5 examples of domestic or industrial pollutants.

c) purification

64. State 3 methods of control of terrestrial pollution caused by solid waste.
65. Discuss the relative merits of each of these methods.

11.42 Personal "anti-pollution" contribution

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67. Describe an anti-pollution program containing 10 ways of limiting one's contribution to pollution caused by solid waste.

PHYSICS 452 AND 552, CONTENT AND OBJECTIVES

The objectives of Physics 220-452 and 220-552 are outlined on the left side of the page. These objectives, taken from the pedagogical guide (document 16-3128) suggested then a teaching time between 120 to 150 hours.

The right hand side of the page is a sample guide aimed at teaching the essentials of the program over a period of 100 hours. You will notice that some objectives are not repeated on the right hand side. Therefore these objectives do not have to be taught for themselves but only when necessary for additional knowledge.

In other instances, some almost entire sections have become "working units" and are not repeated on the right hand side. You could, according to the student's interest in the subject or the time and available material, integrate some of these sections as laboratory demonstrations or as topics to be researched by the students. Such can be the case in optics in the section dealing with particle model and wave model of light.

To determine the "working units" we have taken into consideration the selective criteria mentionned in the preliminary pages of this document. However, it is up to the teachers to make modifications whenever needed by using the suggested guide lines listed at the beginning of this document.

PHYSICS 452

TOTAL TEACHING TIME 150 hours

A- BASIC NOTIONS

1. Time, space, matter and measures

   . Definition and measure of time, space, matter, units

   . Limitations of measuring: notion of errors; significant figures

   Laboratory

   . Measures of distance

   . Short intervals of time

   . Precision and limitation of measuring

2. Mathematical instruments *

   . Mathematical relations: direct and inverse proportions, proportionality constant, slopes, power laws, similar figures, the inverse square relation, equations, functions, graphical representations.

   . Interpolation and extrapolation

   . Trigonometric functions: sine, cosine and tangent

TOTAL TEACHING TIME 100 hours

A- BASIC NOTIONS

The notions in this section can be dealt as needed. This is to say, that they are to be used whenever they are necessary for the acquisitions of additional knowledge. The section pertaining to mathematical instruments can also be treated in the same manner.

TOTAL TEACHING TIME 150 hours

Laboratory

. Graph a direct proportion

. Analysis of an experiment

• This section can be dealt with as needed.

B- OPTICS

1. Optical geometry

. Sources of light; general considerations of light.

. Reflection and images; shadows; beams; pencils and rays of light; laws of reflection; plane and parabolic mirrors; projectors and astronomical telescopes; real and virtual images.

. Refraction; experiments on the angles of refraction; Snell's Law; relative and absolute indices of refraction; the passage of light from one medium to another; reversibility; total internal reflection; refraction by prisms; dispersion.

. Convergence by a set of prisms; lenses; real images formed by lenses.

Laboratory

. Qualitative experiments on general concepts

TOTAL TEACHING TIME 100 hours

B- OPTICS

1. Optical geometry

. Sources of light; general considerations of light.

. Reflection and images; shadows; beams; pencils and rays of light; laws of reflection; plane and parabolic mirrors; projectors and astronomical telescopes; real and virtual images.

. Refraction; experiments on the angles of refraction; Snell's Law; relative and absolute indices of refraction; the passage of light from one medium to another; reversibility; total internal reflection; refraction by prisms; dispersion.

. Convergence by a set of prisms; lenses; real images formed by lenses.

Laboratory

. Qualitative experiments on general concepts

TOTAL TEACHING TIME 150 hours

- Reflection from a plane mirror
- Refraction
- Images formed by a converging lens.

2. The particle model of light

- Particle model of light
- Reflection, refraction, intensity of illumination, pressure of light, absorption and heating, speed of light and the theory of refraction, some difficulties with the particle theory.
- Notion of model.

Laboratory

- Refraction of particles.

3. The wave model of light

- Pulses and waves, waves on coil springs, superposition of waves, reflection and transmission; water waves; straight and circular pulses; reflection; refraction; dispersion and refraction of waves; speed of propagation.
- Periodic waves.
- Interference produced by two point sources; nodal lines; wave lenghts;

TOTAL TEACHING TIME 100 hours

- Reflection from a plane mirror
- Refraction
- Images formed by a converging lens.

TOTAL TEACHING TIME 150 hours

source separation, angles, phase.

. Young's experiment; interference of light waves; colours and wave lenght of light; diffraction of light by single and double slits.

Laboratory

. Waves on a coil spring
. Pulses on the surface of water
. Periodic waves
. Refraction of waves
. Waves and obstacles
. Waves from two point sources
. Interference and phase
. Young's experiment
. Diffraction of light by a single slit.

C- MECHANICS

1. Kinematics

. Scalar distances and vector displacements

. Average speed, instantaneous speed, velocity vector

. Average acceleration; instantaneous acceleration, vector acceleration

. Description of motion, frames of reference, trajectories and vector components

TOTAL TEACHING TIME 100 hours

C- MECHANICS

1. Kinematics

. Scalar distances and vector displacements

. Average speed, instantaneous speed, velocity vector

. Average acceleration; instantaneous acceleration, vector acceleration

. Description of motion, frames of reference, trajectories and vector components

TOTAL TEACHING TIME 150 hours

. Analysis of velocity-time, position-time and acceleration-time graphs. Slope, tangent, area under a curve

. Uniform rectilinear motion and uniformly varied rectilinear motion

. Motion at variable speed and constant acceleration

Laboratory

. Motion: variable speed and acceleration

. Motion: variable speed and constant acceleration

2. Dynamics

. Relation between force and motion

. Changes in velocity when a constant force acts; acceleration

. Inertial and gravitational mass

. Newton's Law; dynamical measurement of force; units

. Vector nature of forces, resultant and equilibrant forces; systems in equilibrium

. Weight; gravitational field of the earth; free fall and motion of a projectile (vector nature of Newton's Law; trajectory)

TOTAL TEACHING TIME 100 hours

. Analysis of velocity-time, position-time, and acceleration-time graphs. Slope, tangent, area under a curve

. Uniform rectilinear motion and uniformly varied rectilinear motion

. Motion at variable speed and constant acceleration.

Laboratory

. Motion: variable speed and acceleration

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. Newton's Law; dynamical measurement of force; units

. Vector nature of forces, resultant and equilibrant forces; systems in equilibrium

. Weight; gravitational field of the earth; free fall and motion of a projectile (vector nature of Newton's Law; trajectory)

TOTAL TEACHING TIME 150 hours

- Circular motion; centripetal and centrifugal forces; satellites
- Universal gravitation and the solar system different planetary systems; Kepler's Law universal gravitation

Laboratory

- Changes in velocity with a constant force
- The dependence of acceleration upon force and mass
- Inertial and gravitational mass
- Forces on a ball in flight
- Projectiles
- Centripetal force
- Law of equal areas

TOTAL TEACHING TIME 100 hours

- Circular motion; centripetal and centrifugal forces; satellites
- Universal gravitation

Laboratory

- Changes in velocity with a constant force
- The dependence of acceleration upon force and mass
- Projectiles
- Centripetal force

PHYSICS 552

3. Energy and its conservation

- Impulse; momentum; the law of conservation of momentum
- Work; kinetic energy; conservation of kinetic energy in elastic collisions; loss of kinetic energy in a frictional interaction
- Potential energy of a spring; potential gravitational energy; escape energy and binding energy of satellites
- Thermal energy; conservation of energy

Laboratory

- Momentum changes in an explosion
- Conservation of momentum
- Collision in a two dimensional space
- Head-on collision
- Changes in potential energy
- Energy of a simple pendulum

3. Energy and its conservation

- Impulse; momentum; the law of conservation of momentum
- Work; kinetic energy; conservation of kinetic energy in elastic collisions; loss of kinetic energy in a frictional interaction
- Potential energy of a spring; potential gravitational energy at earth's surface
- Conservation of energy

Laboratory

- Momentum changes in an explosion
- Conservation of momentum
- Collision in a two dimensional space
- Head-on collision
- Changes in potential energy
- Energy of a simple pendulum

TOTAL TEACHING TIME 150 hours

D- ELECTRICITY AND MAGNETISM

1. Electrostatics

. Electric charges; attraction; repulsion; insulators; conductors; induction

. Electrical forces; Coulomb's Law; electric field; elementary charges; Millikan's experiment

Laboratory

. Electrified objects

. Electrostatic induction

. The force between two charged spheres

. The Millikan experiment

2. Electric charges in motion

. Motion of charged particles in an electric field; electron and proton

. Conductivity of gases, solutions and metals

. Electric current; Electrolytic measurement of currents; batteries; electromotive forces

. Electric field and potential difference

. Electric circuits; Ohm's Law and Kirchoff's Law

TOTAL TEACHING TIME 100 hours

D- ELECTRICITY AND MAGNETISM

1. Electrostatics

. Electric charges; attraction; repulsion; insulators; conductors; induction

. Electrical forces; Coulomb's Law; electric field

Laboratory

. Electrified objects

. The force between two charged spheres

. The Millikan experiment

2. Electric charges in motion

. Motion of charged particles in an electric field; electron and proton

. Electric current; batteries; electromotive forces

. Electric field and potential difference

. Electric circuits; Ohm's Law, series and parallel circuits

TOTAL TEACHING TIME 150 hours

Laboratory

- Potential difference
- Charges of ions in solution
- Electric circuits (Ohm's and Kirchoff's Laws)

3. Magnetic field

- Magnetic fields of magnets and currents magnetic field lines; vector addition of magnetic fields
- Forces on currents in magnetic fields; force operative between two rectilinear parallel currents; forces on moving charged particles in a magnetic field
- Meters and motors; using magnetic fields to measure the masses of charges particles

Laboratory

- Pole and magnetic spectra
- Magnetic field of a current
- Magnetic field near a long, straight wire
- The measurement of a magnetic field in fundamental units

TOTAL TEACHING TIME 100 hours

Laboratory

- Electric circuits (Ohm's Law)

3. Magnetic field

- Magnetic fields of magnets and currents magnetic field lines; vector addition of magnetic fields
- Forces of currents in magnetic fields; forces on moving charged particles in a magnetic field
- Meters and motors

Laboratory

- Magnetic field of a current
- The measurement of a magnetic field in fundamental units

TOTAL TEACHING TIME 150 hours

. Mass of an electron

. Energy transferred by an electric motor

4. Electromagnetic induction

. Induced current and induced electromotive force; energy of an electromotive force; relative motion

. Magnetic flux and the law of induction. Induction in the cases of immobile circuits; Electric fields around changing magnetic fluxes

. Self induction and electric oscillators; magnetic fields around changing electric fluxes

Laboratory

. Induction (qualitative experiments)

E- MODERN PHYSICS

1. The Rutherford Atom

. The Rutherford model of the atom trajectories of alpha particles in the electric field of a nucleus; angular distribution of scattering

Laboratory

. Randomness in decay

TOTAL TEACHING TIME 100 hours

4. Electromagnetic induction

. Induced current and induced electromotive force; energy of an electromotive force; relative motion.

. Magnetic flux and the law of induction

. Alternate currents, transformators.....

Laboratory

E- MODERN PHYSICS

TOTAL TEACHING TIME 150 hours

TOTAL TEACHING TIME 100 hours

2. Photons and matter waves

. The graininess of light; the photon; probability of photonic bombardment; graininess and interference; photo-electric effects; mechanics of the photon; Compton effect

. Photons and electromagnetic waves; radiation and electric-spectra; matter waves

Laboratory

. Simulated nuclear collisions

3. Atomic structure and Quantum theory

. Experiments of Frank and Hertz, energy levels; excitation and emission, atomic spectra; absorption spectra; energy levels of hydrogen; wave theory of energy levels

Laboratory

. Spectrum of the elements

GENERAL OBJECTIVES AND NOTIONAL CONTENT OF SCIENCE 412 PROGRAM

This program is meant for students who don't like or feel incapable to follow the other Chemistry or Physics programs that are presently offered.

Because of the difficulties faced in other science courses due to the approach taken as well as the varied elements of notional content, this program, differs in some notional elements as well as in their approach and in the degree of in depth knowledge required. This program is not a diluted version of the other programs and it is difficult enough to be accepted as a secondary four program suitable to a particular group of students.

The suggested approach is to be concrete rather than abstract, practical rather than theoretical and based on the application of everyday occurences. By means of these proposed notional elements, the teacher should emphasize the experimental approach, links between proposed elements and their application to everyday occurrences. It is then in this spirit and with simple language that these notional elements are to be conveyed. Students must be gradually led to build up certain concepts by means of these everyday occurrences and avoid learning these concepts from a theoretical viewpoint in the light of some type of specialization.

The original version of General Science 412 introduced three themes: Chemistry, Physics and Biology. The latter could be taught either first or last. For this modified version we have omitted the section on Biology as Human Biology is compulsory in secondary three and future compulsory science programs in secondary four will only consist of chemistry and physics elements.

The Ministry of Education of Quebec has drawn from the original version of this program and modified versions presently used by certain school commissions for this revised version of General Science 412. You will find in the following pages a certain number of subjects to be studied that are not expressed in the form of specific objectives. Reference must always be made to the principles written on the first page in order to retain the objectives to be achieved by means of each of the notional elements mentioned. The general objectives are:

- Awaken the student's interest
- Develop the sense of obsevation
- Develop the critical mind
- Encourage the learning of basic knowledge
- Familiarize the student with the scientific approach in order to:
  - understand the true sense of the physical world;
  - acquire sufficient indipendent spirit ot express original ideas based on actual facts;
  - to convince himself of the essential character of his contribution to society.

NOTIONAL CONTENT

1. Basic ideas

- Idea of what is "science"
- Difference between science and technology
- The scientific method: description and application
- Construction and application of graphs
- The international system of units (simple operations)
- Distinction between mass and weight (units of measure)
- Temperature: conventional scales, conversion from degrees Kelvin to degrees Celsius
- Atmospheric pressure, barometers

NOTE: All of these basic ideas can be incorporated whenever necessary, that is to say, when they are required for additional knowledge. They also become experiments done in laboratory.

2. Matter and energy

- Concept of the classification of matter
- Classification: solids, liquids and gases
- Three states of water as an example
- Critical point of change; the effect of pressure
- Properties of matter as a classification method; variety of properties including density (application of the mass/volume ratio)
- Classification of mixtures and pure substances
- Organic and inorganic compounds as another form of classification (distinguish between them)
- Symbols of simple elements (the first twenty elements of the periodic table as well as some common elements)

3. Molecules and atoms

- Kinetic molecular theory, concept of kinetic energy and heat. (briefly)
- Parts of the atom (protons, neutrons and electrons)
- Arrangement of electrons, protons and neutrons of the first twenty elements in the periodic table. Configuration of the electrons according to Bohr's model and with the aid of the periodic table (families and periods)
- Concept of "isotopes" and current applications
- Concept of the combination of atoms to form compounds
- Molecular models. Simple molecular formulas and nomenclature (compounds may be formed using the rule of eight)
- Physical and/or chemical changes (experimental approach and everyday occurrences)
- Relations between energy and chemical reactions; the different forms of energy and their interreletionship. Distinction between exothermic and endothermic
- Simple chemical equations: concept, symbolism and balancing of simple equations
- Concept of the conservation of mass
- Acids and bases (general ideas and examples of everyday reactions)

4. Work and energy

- Notions of force. The effect of a force, the measurement of a force
- The concept of inertia, action and reaction. Examples of jet propulsion. Centripetal and centrifugal force and friction. Gravitational force (make the link between mass and weight). Give examples of the application of these principles from everyday occurrences

- Mechanical advantage, the theory and practice of simple machines: levers, pulleys, inclined plane, etc.
- Notions of work. General equation and simple calculations
- Notions of power and simple calculations

5. Thermal energy

- Sources of heat. Units of heat.
- Specific heat.
- Distinction between heat and temperature. Units and measures.
- Thermal exchanges. Conductors and insulators. Refrigeration, heating, etc.

6. Heat engines

- Principles of expansion
- The workings of selected heat engines: steam engine, turbine, internal combustion engine, external combustion engines, 4 cycle motors, etc.

7. Light

- Sources of light
- Propagation of light
- Reflection, refraction, Lenses.

8. Magnetism

- Types of magnets
- Attraction laws

- Magnetic field notions
- The compass
- Machines functioning by means of a magnetic field produced by a magnet and/or an electric current.

9. Electricity

- Electrostatics
- Electric current
- Electrical circuits: in series and in parallel
- Ohm's Law
- The measure of energy. Utilization costs of electrical equipment.

NOTE: The ability of the students and the allotted time will determine "how far you can go" in the teaching of the suggested notions. One must always keep in mind the concrete and not the abstract aspect, the practical and not the theoretical side of this program.

PHYSICS BLOCKS I AND II, PHYSICS 441

These three programs have been developed in the optic of a 100 hour time table; this is the reason why we haven't given any directions to make them operational. If you are already teaching these programs you can continue. It is not however reccommended to introduce the above programs as new ones will soon be brought forth.

PHYSICS 522 AND GENERAL PHYSICAL SCIENCE 422

Useful information will be provided in the near future on how to apply Physics 522. As for General Physical Science 422 we have not founded necessary to provide directions for application in 100 hours as this program is presently hardly taught. However, if you want to absolutely teach the program in 100 hours and have not already made the necessary changes you can contact us for informations.

Gouvernement du Québec
Ministère
de l'Éducation

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